

## CLAIMS

What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. An analog to digital (A/D) converter, comprising:

a counter circuit for storing a digital word;

a ramp generator for generating a sequence of reference voltages which vary in accordance with at least a first transfer function of said digital word and a second transfer function of said digital word;

a comparator for comparing the magnitude of one of said reference voltages with a magnitude of an input signal; and

a control circuit for determining the digital word corresponding to the input signal by repeatedly:

comparing the magnitude of the input signal with the magnitude of a most recently generated reference voltage of said sequence,

incrementing said counter, and

causing said ramp generator to generate a new one of said sequence

until the magnitude of the most recently generated reference voltage of said sequence exceeds the magnitude of said input signal.

2. The converter of claim 1, wherein said first transfer function maps each digital word stored in said counter below a first threshold to a corresponding reference signal in a linear manner.
3. The converter of claim 2, wherein said second transfer function maps a set of non-sequential and increasing digital words stored in said counter each having a magnitude at least equal to said first threshold to corresponding reference signals in a linear manner.
4. The converter of claim 2, wherein said second transfer function maps each increasing digital word stored in said counter having a magnitude at least equal to said first threshold to corresponding reference signals in a logarithmic manner.
5. The converter of claim 1, wherein said counter circuit comprises:

a controller for receiving a reset signal and a clock signal;

a register, coupled to said controller; and

a memory, coupled to said controller,

wherein:

when a clock signal is supplied to said controller, said controller reads a next value from said memory and stores said next value in said register; and

said memory stores a plurality of numbers in a non-sequential and increasing manner.

6. The converter of claim 5, wherein said memory is a non-volatile memory.

7. The converter of claim 1, wherein said counter circuit comprises:

a counter; and

circuitry for incrementing said digital word stored in said counter by one.

8. The converter of claim 1, wherein said ramp generator comprises:

a plurality of capacitor banks, each bank comprising:

a plurality of capacitors having equal capacitance;

a bank output line coupled to a first plate of each capacitor; and

a bank control circuit, coupled to a second plate of each capacitor, and for

switchably coupling the second plate of any one of said capacitors to either a first voltage source or a second voltage source;

a master output line, coupled to each bank output line; and

a master controller, for sending control signal to each bank control circuit to a master voltage at said master output line to generate said sequence of voltages.

9. The converter of claim 8, wherein a capacitance of any capacitor in a first capacitor bank is different from a capacitance of any capacitor in a second capacitor bank.

10. The converter of claim 8, wherein the capacitance of any capacitor in a first capacitor bank is a power of 2 of a capacitance of any capacitor in a second capacitor bank.

11. A imaging system, comprising:

a pixel array;

a sample and hold circuit, coupled to said pixel array;

a driver, coupled to said sample and hold circuit;

an analog to digital (A/D) converter, coupled to said sample and hold circuit, said A/D converter comprising:

a counter circuit for storing a digital word;

a ramp generator for generating a sequence of reference voltages which vary in accordance with at least a first transfer function of said digital word and a second transfer function of said digital word;

a comparator for comparing the magnitude of one of said reference voltages with a magnitude of an input signal; and

a control circuit for determining the digital word corresponding to the input signal by repeatedly:

comparing the magnitude of the input signal with the magnitude of a most recently generated reference voltage of said sequence,

incrementing said counter, and

causing said ramp generator to generate a new one of said sequence,

until the magnitude of the most recently generated reference voltage of said

sequence exceeds the magnitude of said input signal;

a digital processing circuit, coupled said A/D converter;

a storage circuit, coupled to said digital processing circuit; and

a control circuit, coupled to said pixel array, sample and hold circuit, driver, A/D

converter, digital processing circuit, and storage circuit.

12. The imaging system of claim 11, wherein said first transfer function maps each digital word stored in said counter below said first threshold to a corresponding reference signal in a linear manner.

13. The imaging system of claim 12, wherein said second transfer function maps a set of non-sequential and increasing digital words stored in said counter each having a magnitude at least equal to said first threshold to corresponding reference signals in a linear manner.

14. The imaging system of claim 12, wherein said second transfer function maps each increasing digital word stored in said counter having a magnitude at least equal to said first threshold to corresponding reference signals in a logarithmic manner.

15. The imaging system of claim 11, wherein said counter circuit comprises:

a controller for receiving a reset signal and a clock signal;

a register, coupled to said controller; and

a memory, coupled to said controller;

wherein:

when a clock signal is supplied to said controller, said controller reads a next value from said memory and stores said next value in said register; and

said memory stores a plurality of numbers in a non-sequential and increasing manner.

16. The imaging system of claim 15, wherein said memory is a non-volatile memory.

17. The imaging system of claim 11, wherein said counter circuit comprises:

a counter; and

circuitry for incrementing said digital word stored in said counter by one.

18. The imaging system of claim 11, wherein said ramp generator comprises:

a plurality of capacitor banks, each bank comprising:

a plurality of capacitors having equal capacitance;

a bank output line, coupled to a first plate of each capacitor; and

a bank control circuit, coupled to a second plate of each capacitor, and for

switchably coupling the second plate of any one of said capacitors to either a first

voltage source or a second voltage source;

a master output line, coupled to each bank output line; and

a master controller, for sending control signal to each bank control circuit to a master

voltage at said master output line to generate said sequence of voltages.



19. The imaging system of claim 18, wherein a capacitance of any capacitor in a first capacitor bank is different from a capacitance of any capacitor in a second capacitor bank.

20. The imaging system of claim 18, wherein the capacitance of any capacitor in a first capacitor bank is a power of 2 of a capacitance of any capacitor in a second capacitor bank.

21. A processor based system, comprising:

a bus;

a processor coupled to said bus;

a imaging subsystem, coupled to said bus;

wherein said imaging subsystem comprises:

a pixel array;

a sample and hold circuit, coupled to said pixel array;

a driver, coupled to said sample and hold circuit;

an analog to digital (A/D) converter, coupled to said sample and hold circuit,  
said A/D converter comprising:

a counter circuit for storing a digital word;

a ramp generator for generating a sequence of reference voltages which  
vary in accordance with at least a first transfer function of said digital  
word and a second transfer function of said digital word;

a comparator for comparing the magnitude of one of said reference  
voltages with a magnitude of an input signal; and

a first control circuit for determining the digital word corresponding to  
the input signal by repeatedly

comparing the magnitude of the input signal with the magnitude of  
a most recently generated reference voltage of said sequence,

incrementing said counter, and

causing said ramp generator to generate a new one of said  
sequence, until the magnitude of the most recently generated  
reference voltage of said sequence exceeds the magnitude of said  
input signal;

a digital processing circuit, coupled said A/D converter;

a storage circuit, coupled to said digital processing circuit; and

a second control circuit, coupled to said pixel array, sample and hold circuit, driver, A/D converter, digital processing circuit, and storage circuit.

22. The system of claim 21, wherein said first transfer function maps each digital word stored in said counter below said first threshold to a corresponding reference signal in a linear manner.

23. The system of claim 22, wherein said second transfer function maps a set of non-sequential and increasing digital words stored in said counter each having a magnitude at least equal to said first threshold to corresponding reference signals in a linear manner.

24. The system of claim 22, wherein said second transfer function maps each increasing digital word stored in said counter having a magnitude at least equal to said first threshold to corresponding reference signals in a logarithmic manner.

25. The system of claim 21, wherein said counter circuit comprises:

a controller for receiving a reset signal and a clock signal;

a register, coupled to said controller; and

a memory, coupled to said controller;

wherein:

when a clock signal is supplied to said controller, said controller reads a next value from said memory and stores said next value in said register; and

said memory stores a plurality of number in a non-sequential and increasing manner.

26. The system of claim 25, wherein said memory is a non-volatile memory.

27. The system of claim 21, wherein said counter circuit comprises:

a counter; and

circuitry for incrementing said digital word stored in said counter by one.

28. The system of claim 21, wherein said ramp generator comprises:

a plurality of capacitor banks, each bank comprising:

a plurality of capacitors having equal capacitance;

a bank output line, coupled to a first plate of each capacitor; and

a bank control circuit, coupled to a second plate of each capacitor, and for

switchably coupling the second plate of any one of said capacitors to either a first voltage source or a second voltage source;

a master output line, coupled to each bank output line; and

a master controller, for sending control signal to each bank control circuit to a master voltage at said master output line to generate said sequence of voltages.

29. The system of claim 28, wherein a capacitance of any capacitor in a first capacitor bank is different from a capacitance of any capacitor in a second capacitor bank.

30. The system of claim 28, wherein the capacitance of any capacitor in a first capacitor bank is a power of 2 of a capacitance of any capacitor in a second capacitor bank.

31. A method for converting an analog signal to a digital word, comprising:

measuring a magnitude of said analog signal;

if said magnitude is not greater than a first threshold, mapping said magnitude to a digital word in accordance with a first transfer function; and

if said magnitude is at least equal to said first threshold, mapping said magnitude to the digital word in accordance with a second transfer function.

32. The method of claim 31, wherein said first transfer function maps each magnitude below said first threshold to a corresponding reference signal in a linear manner.

33. The method of claim 32, wherein said second transfer function maps a set of non-sequential and increasing magnitudes each at least equal to said first threshold to corresponding reference signals in a linear manner.

34. The method of claim 32, wherein said second transfer function maps each magnitude at least equal to said first threshold to corresponding reference signals in a logarithmic manner.

35. A method for generating a sequence of reference voltages, comprising:

receiving a sequence of clock signals; and

on each clock signal,

reading a plurality of control words from a memory, each one of said plurality of control words corresponding to a different one of a plurality of capacitor banks;

for each one of said plurality of capacitor banks, sending or not sending a control and reset signal based on the content of a corresponding control word;

at each capacitor bank, controlling a plurality of switches, each of said switches associated with a capacitor and controlling which one of a plurality of voltage sources which is coupled one plate of said capacitor, to produce a bank output voltage; and

summing each bank output voltage to produce a master output voltage.

36. A method for operating an imaging system, comprising:

receiving an analog pixel signal from a pixel;

converting said analog pixel signal into a digital word, wherein said converting comprises:

measuring a magnitude of said analog signal;

if said magnitude is not greater than a first threshold, mapping said magnitude to a digital word in accordance with a first transfer function; and

if said magnitude is at least equal to said first threshold, mapping said magnitude to the digital word in accordance with a second transfer function.

37. The method of claim 36, wherein said first transfer function maps each magnitude below said first threshold to a corresponding reference signal in a linear manner.

38. The method of claim 37, wherein said second transfer function maps a set of non-sequential and increasing magnitudes each at least equal to said first threshold to corresponding reference signals in a linear manner.



39. The method of claim 37, wherein said second transfer function maps each magnitude at least equal to said first threshold to corresponding reference signals in a logarithmic manner.

40. A imaging system, comprising:

a pixel array;

an analog to digital (A/D) converter circuit that receives analog signals from the pixel array and converts the analog signals to digital signals;

wherein said A/D converter circuit converts with a variable level of quantization.

41. The imaging system of claim 40, wherein said A/D converter circuit comprises:  
a variable quantization A/D converter.

42. The imaging system of claim 41, wherein said variable quantization A/D converter is a ramp type A/D converter.

43. The imaging system of claim 40, wherein said A/D converter circuit comprises:

a linear A/D converter; and

a processing circuit that remaps values output by said linear A/D converter.

44. The imaging system of claim 43, wherein said processing circuit remaps values by consulting a mapping table.

45. An integrated circuit, comprising:

a pixel array, disposed on said integrated circuit; and

an analog to digital (A/D) converter circuit, disposed on said integrated circuit, wherein said analog to digital converter circuit receives analog signals from the pixel array and converts the analog signals to digital signals with a variable level of quantization.

46. The integrated circuit of claim 40, wherein said A/D converter circuit comprises:

a variable quantization A/D converter.

47. The integrated circuit of claim 40, wherein said A/D converter circuit comprises:

a linear A/D converter; and

a processing circuit that remaps values output by said linear A/D converter.